

2D MODELLING AND ITS APPLICATIONS in ENGINEERING

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Abstract

A model, in computer aided engineering applications, may be created by either using a two-dimensional or a three-dimensional design depending on the purpose of design. What matters most in this regard is the selection of a right method to meet system solution requirements in the most economical way. Manufacturability of a design that is developed by utilising computer aided engineering is important, but usability of the data obtained in the course of design works in the production is also equally important. In the applications consisting of such production operations as CNC or plasma cutting, two-dimensional designs can be directly used in production. These machines are equipped with interfaces which converts two-dimensional drawings into codes. In this way, a design can be directly transferred to production, and any arrangements during production process can be synchronously evaluated. As a result of this, investment expenses will be lowered, and thus the costs can be reduced to some extent.

In the presented study, we have studied two-dimensional design applications and requirements. We created a two-dimensional design for a part for which a three-dimensional model have previously been generated, and then, we transferred this design to plasma cutting machine, and thus, the operation has been realized experimentally.

Key words: Plasma Cutting, 2D modelling, flexibility

1. INTRODUCTION

Construction process is the whole creative intellectual activities exerted to find a solution for a technical problem, a requirement, generally as a technical production, within engineering knowledge and experiences. While until mid-twentieth century construction was rather regarded as an innate talent, the opinion that construction could be a teachable and learnable discipline has been prevailing particularly during the last twenty five years. Technological developments beginning from computer-aided engineering programs and extending to databanks, incorporating also artificial intelligence have strengthened this trend as well. At every step of construction process, fitness of the result derived to the purpose is checked so that probable faults and deficiencies are noticed timely and necessary corrections are made (Çavdar and Babalık, 2003).

From emergence of the technical product as an idea in human brain to offering of the first usable product to the market, the following steps are pursued for solution of any problem regardless of whatever the problem is:

- Understanding, revealing the task with all details
- Finding and recording as many as possible possibilities of solution
- Selecting the most appropriate one among the solution offers presented
- Detailing step where drawings of the solution selected are made and prepared for production

- Prototype production, tests and mass production permit

Although construction and development steps constitute 10% of the expenditures made for creation of the product in product development activity, they affect a substantial part, i.e. 70% of the product cost. What the result will be in a construction is determined by the decisions given in the beginning (Babalík, 2006).

Certain periods are required for realization of these steps. When reviewed historical development, periods that could formerly be regarded very long are observed to have extremely shortened for the products developed in the last quarter of the twentieth century.

While advanced developments in the computer technology have increased effectiveness of the engineering applications, computer-aided solutions, they have ensured shortening of the design process. In computer-aided engineering, design is attained as two dimensional or three dimensional model. The better a two or three dimensional model created in computer medium represents the real prototype, the more successful analysis results of the design are. Analysis studies conducted on the model allow bringing the workpiece to its final dimensions with repeated analyses. While two dimensional design programs can be used in mesh systems and plate designs, three dimensional models are preferred for systems not exhibiting a linear structure, but in cases where 3D model cannot be realized, two dimensional solutions are realized by making assumptions. Moreover, 3D software is not required to be available in all enterprises. For example, md solids and ansys applications are also available for the systems capable of analysis on two dimensions.

Design process is followed by production process. Realization of the design in computer medium in the production process has many advantages. If CNC or Plasma cutting robot applications will be performed in the production process of a three dimensional solid model or a two dimensional design, then a code for production should be written. Plasma and oxygen cutting is often preferred especially for 2D sheet workpieces with fixed thickness. Today, commercial software converting 2D designs into processing codes are available for this purpose. Therefore, drawings converted into two dimensions are very effective in production.

This study explains 2D design applications with 3 different examples. In first example, the flange section on a model of a container designed as 3D was attained as 2D on CATIA. But as the interface software was suitable for AUTOCAD drawings, the 2D CATIA model was converted into 2D AUTOCAD model. The second example illustrates a complex workpiece, data of which may take a long time to obtain with classic coding system. Last example is given for production of a workpiece created only in AUTOCAD environment.

2. EXPERIMENTAL STUDY

In this study, all practical operations have been performed with plasma cutting operation. For the shaping of materials a wide range of thermal cutting techniques are available nowadays. One of them is Plasma Arc Cutting (PAC). It is a non-conventional manufacturing process capable of processing a variety of electrically conducting materials. Stainless steel, manganese steel, titanium alloys, copper, magnesium, aluminium and its alloys and cast iron can be processed. Although the origin of the plasma-arc process goes back to 1941, the plasma process for cutting was developed approximately thirty years ago, for metals difficult to be machined through conventional processes. It uses a high-energy stream of dissociated, ionized gas, known as plasma, as the heat source (Salonitis 2007). Salonitis(2007) performed an experimental study on oxygen plasma cutting process for assessing the quality of the cut and determination of the most important parameters that influence the cutting quality. Application of the moving-boundary methodology in the modelling of thermal plasma cutting

of materials was carried out by Narimanyan (2009). The aim of the model was to determine the temperature distribution in the workpiece and the geometry of the cutting front during the cut. Schulz et al (1997) described the cutting process of the workpiece. The discussions have been done for a 3D free boundary problem for the motion of one step boundary. Xi and Kar (1997) investigated a one-dimensional heat conduction problem and melting rate during laser materials processing. The quality of cuts performed on titanium sheets using high tolerance plasma arc cutting (HTPAC) process has been investigated under different process conditions by Gariboldi (2005). Monno (1999) aimed at the identification of the process parameter range when titanium sheets are cut with different shielding and cutting gases.

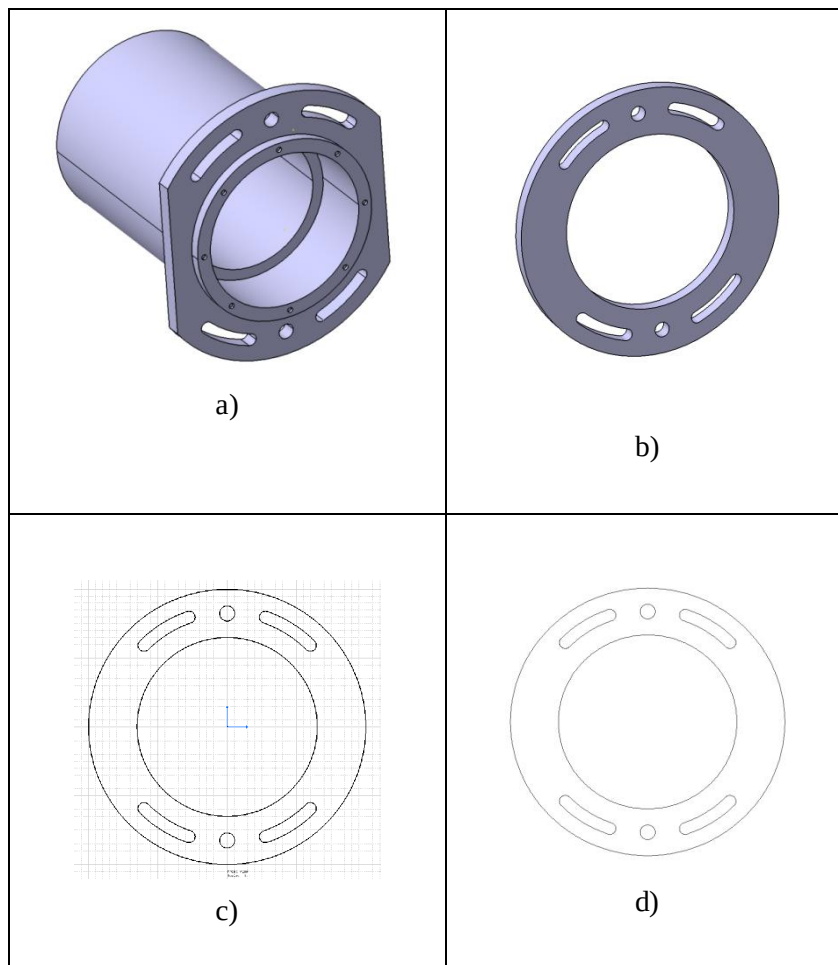


Figure 1. Solid model of container flange

a) 3D CAD model b) Flange CAD model c) CATIA Drafting d) AutoCAD 2D model

2.1. First Example

First example is container flange and relevant images are shown in Figure 1.a. The workpiece which is an outer ring container of a ball bearing will be modeled as 3D with CATIA. In production plan of this

design, it was considered suitable to join the flange to the container by welding. Thus, the flange will be produced separately from the container. The flange will be first cut by plasma from 15 mm thick sheet plate, and will be brought to its finishing dimensions on the lathe. Therefore, 3D model was designed circular for connection of the flange to the lathe without problem (Figure 1.b.). 2D model pertaining to this 3D model was first created on CATIA drafting module (Figure 1.c.). However, plasma cutting lathe automation interface recognizes 2D models in AutoCAD format. Therefore, 2D design was converted into AutoCAD format in the last step of the design (Figure 1.d.).

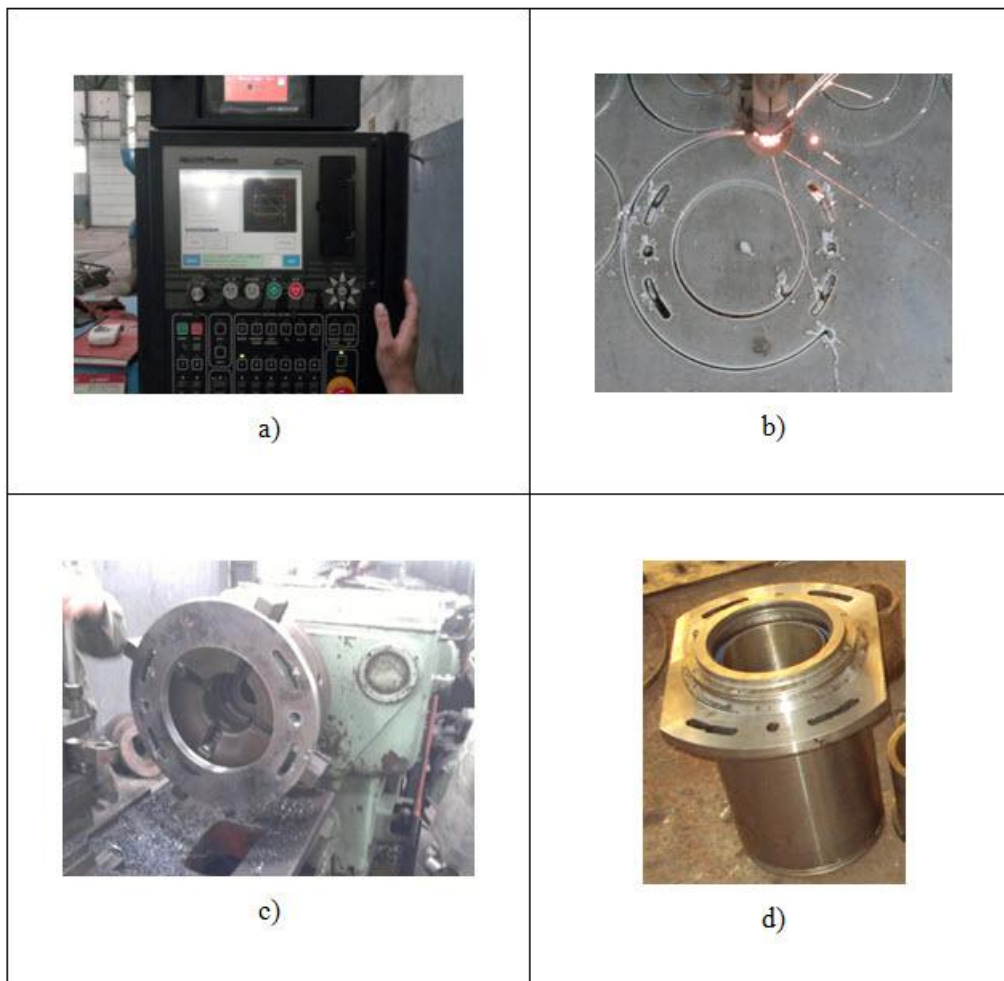


Figure 2. Process steps of container flange

a) Plasma cutting interface b) Cutting operation c) Lathe operation d) Final part

2D design created in AutoCAD format (*.dwg) was transferred to the plasma cutting lathe automation system interface online or with memory stick (Figure 2.a.). Starting point of the plasma cutting operation and the areas that will be waste following cutting operation are defined on this interface. Interface software converts the geometries on 2D AutoCAD data created depending on the determined starting point of the operation and the defined operation order. Based on thickness and material of the

sheet to be cut, plasma cutting flame and cutting proceeding speed settings are selected by the operator. Following these procedures, cutting operation was performed and was measured as 90 sec. for such operation (Figure 2.b.). Thereafter, welding opening was made for the flange on the lathe (Figure 2.c.) and after milling the flange edges, it was mounted on the container by welding (Figure 2.d.). Thus, production process was accelerated by converting 3D CAD data into 2D model, and the 3D model created was used in production process. Along with the methods used in production process and the production forecast studies of the design, use of CAD data with automation systems in production systems ensure the production be closest to design and standard.



Figure 3. Process steps of side plate

a) Plasma cutting interface b) Cutting operation c) Marking and drilling d) Welded part

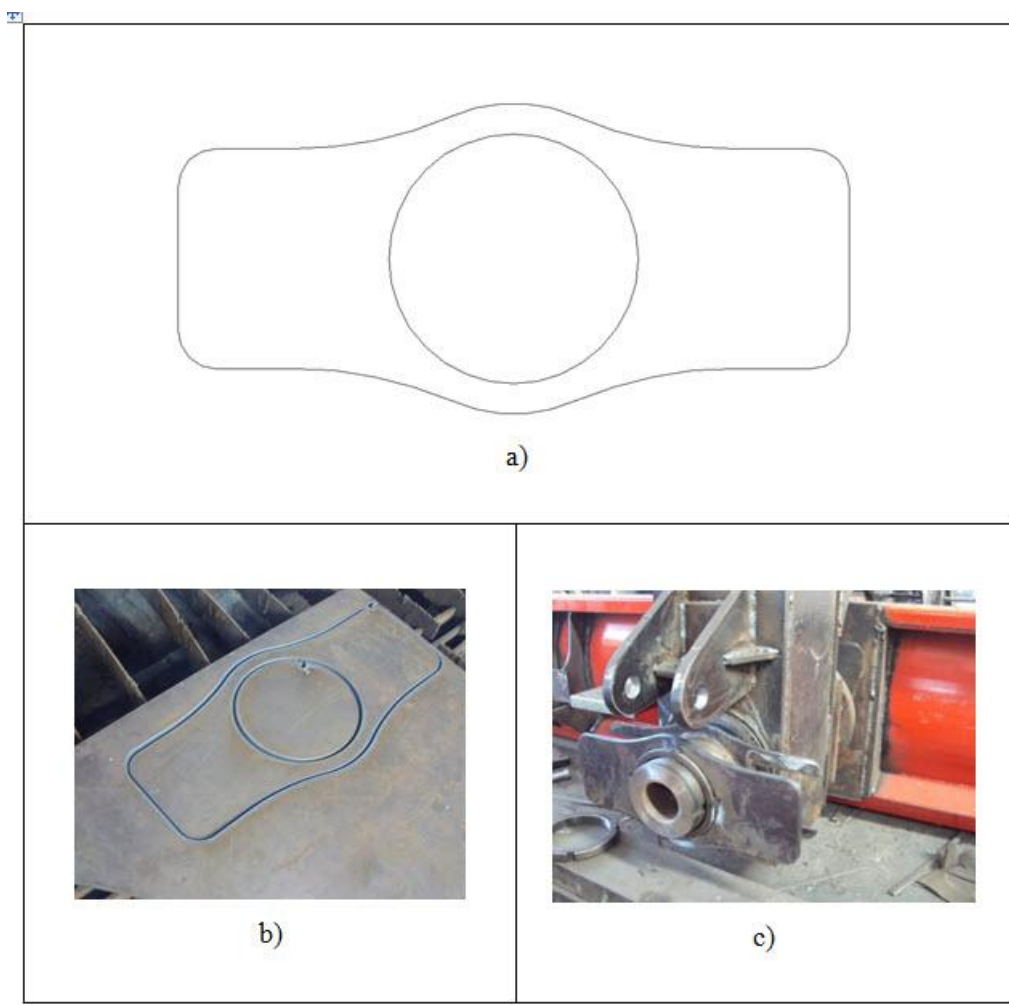


Figure 4. Process steps of connection plate
a) AutoCAD 2D model b) Cutting operation c) Mounted part

2.2. Second Example

Although plasma cutting of circular or defined standard geometries given in first example take a long operation time on automation interface, they can be defined by operator. But this operation is impossible for complex and special geometries even if there is no time limitation. A 2D design is absolutely required for this. This example addresses cutting steps of such a geometry that is complex and impossible to be defined manually. Again, 2D model of a 3D design was created here and transferred to the plasma cutting device in similarly way with first example (Figure 3.a.). Especially in the case of geometries incorporating curves, making maximum number of pieces from a standard shaped sheet is important for efficiency. From this aspect, 2D modeling gains further importance in multiple and standard cutting operations (Figure 3.b.). Moreover, faults are avoided in production by marking the joining elements and reference points on the geometries with 2D modeling (Figure 3.c.).

It is a method that is economical and applied to attain axis sets and templates for production in the case of constructions mass of production of which is not performed (Figure 3.d.).

2.3. Third Example

In first and second examples, plasma cutting operations were performed practically by converting 3D design data into 2D design data. For pieces not requiring 3D design, plasma cutting operations are performed on the model drawn with AutoCAD program. Thus, models of the sheet plates required in the production process can be created in a short time. This example explains production process of support connection plate of a shaft connection system by plasma cutting. The piece AUTOCAD model of which is given in Figure 4.a was cut as shown in Figure 4.b. The sheet plate as mounted in place is shown in Figure 4.c.

3. CONCLUSION

This study presented practical examples regarding transfer of pieces modeled as 2D and 3D to plasma cutting and their production. It was also shown with examples that 3D modeling is not always required especially for pieces with suitable geometry. Based on the presented results, it is concluded that:

- What matters in production process is use of the modeling program that is capable to solve our problem in the shortest time. Investments to be made in comprehensive 3D modeling programs will not always bring an economical solution.
- Some geometrical pieces are converted from 3D design into 2D design. Whereas, pieces with suitable geometry are directly modeled as 2D. In both cases, the data attained can be transferred to operation on the plasma cutting machine.
- In such an automation system, it is possible to make any possible setting during operation concerning the piece to be produced.
- Margin of the plasma cutting operation line should be kept in mind during plasma cutting operations.
- During cutting of pieces, attention should be paid to cut the small geometries first.
- Increase of hardness in the zones cut by plasma should be kept in mind. This should be considered when planning the machining following the cutting operation.

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